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[Grass and Forage Plant Investigations.]

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NOTES

ON THE

GRASSES AND FORAGE PLANTS

OF

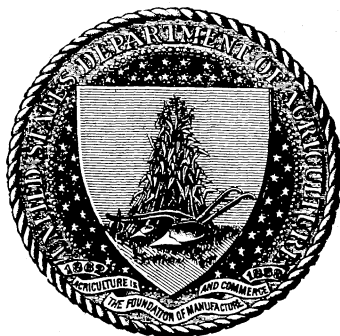
IOWA, NEBRASKA, AND COLORADO.

BY

L. H. PAMMEL,

Professor of Botany in Iowa Agricultural College.

PREPARED UNDER THE DIRECTION OF THE AGROSTOLOGIST.



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1897.

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF AGROSTOLOGY,
Washington, D. C., August 10, 1897.

SIR: I have the honor to transmit herewith and recommend for publication as Bulletin No. 9 of this Division, a report by L. H. Pammel, professor of botany in the Iowa Agricultural College, on the grasses and forage plants of Iowa, Nebraska, and Colorado. The three States included in this report, especially the first named, are great stock-raising States, and all information pertaining to the food supply—the grasses and forage plants—for the cattle, horses, and sheep can not fail to be of interest. This report is in line with the investigations of the grasses and forage plants of the Northwest now being carried on by the Division.

The report here presented is divided into three parts, the first including general observations upon the physical conditions and important questions relative to forage production in the States named; the second is devoted to an enumeration of the more important grasses and forage plants of these States, alphabetically arranged, with economic notes; in the third part the author presents a classified list of the grasses of Iowa, Nebraska, and Colorado collected by him during the seasons of 1895 and 1896.

Respectfully,

F. LAMSON-SCRIBNER,
Agrostologist.

Hon. JAMES WILSON,
Secretary of Agriculture.

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NOTES ON THE GRASSES AND FORAGE PLANTS OF IOWA, NEBRASKA, AND COLORADO.

FIELD NOTES AND GENERAL OBSERVATIONS.

INTRODUCTION.

One of the most important industries in the States of Iowa, Nebraska, and Colorado is that of stock raising, and consequently the forage and the conditions of the native forage plants are subjects of vital interest to the farmer. In order to study these conditions several of the more important points in Iowa west and northwest of Ames were visited at various times in 1895 and 1896, and in the latter year collections and observations were made in the vicinity of Omaha, Lincoln, Crete, Hastings, and McCook, in Nebraska, and also in northern and central Colorado in the vicinity of Fort Morgan, Greeley, Fort Collins, Golden, Denver, and Colorado Springs. Some time was spent in the foothills and mountains west of Fort Collins along the tributaries of the Cache la Poudre, at Clear Creek Canyon west of Golden, at Cheyenne Canyon not far from Colorado Springs, and on Pikes Peak.

IOWA.

GENERAL FEATURES OF CENTRAL AND WESTERN IOWA.

West of Ames there are several important valleys—the Des Moines, Coon, and Boyer; northwest of Carroll there are the Little and Big Sioux, the Maple, and the Floyd. Along the Coon and Des Moines rivers the country is rough, and but little hay is cut, though much of the timber land is used for pasture. Along the Boyer, Maple, and Floyd rivers the immediate banks contain some timber, but the flood plains are open and covered with a luxuriant growth of grasses.

The forage question in central Iowa is very different now from what it was fifteen years ago. At that time considerable areas of unbroken sod still remained. Now the wild prairies have almost ceased to be a factor in the production of hay. The extensive prairies have given way to cultivated fields and pastures. Small unbroken areas occur here and there, but these are chiefly confined to the small drainage basins between hills, and exist largely because in times of considerable precipitation these depressions are too moist for proper cultivation. The Boyer and Maple valleys are noted for the large crops of wild hay

annually produced. The same may be said of the rich alluvial flood plain of the Missouri. This plain varies from a few to 15 miles in width, the average being from 8 to 12. The hay crop constitutes one of the chief sources of revenue for the farmers of this region, and could be made much more important if they would follow a more rational system of cropping.

The chief hay plants cultivated in central Iowa are Timothy, Redtop, Blue-grass, and Red Clover. The principal plants used in pastures are Blue-grass, White Clover, Redtop, and Timothy. In the Boyer and Maple valleys and on the Missouri bottoms the wild grasses predominate. To a limited extent, alfalfa meadows have been started in Carroll, Ida, and Woodbury counties. The loess hills, skirting the Missouri bottoms, are mostly cultivated, though unbroken wild meadows and pastures still remain. In the eastern portion of this district considerable corn fodder is used as forage, the amount used depending largely upon the condition of the pastures and meadows.

Many other grasses have been tried with varying success. Orchard grass, naturalized in many places, is one of the most successful. Tall Oat-grass gives some promise. Perennial Rye-grass is nearly worthless for this section of the State. Italian Rye-grass is unable to resist the cold of our winters and is a complete failure. Meadow Foxtail (*Alopecurus pratensis*) does fairly well as an early grass when sown the season before, but is hardly adapted to this section. The most promising of the recently introduced grasses is Smooth or Hungarian Brome. The Short-Awned Brome has also been tried and is very promising. Rye and Barley are often used as forage plants. German millet and Hungarian-grass find extended use some seasons. Broom-Corn Millet is frequently sown in northern and northwestern Iowa.

But one legume is generally grown, and that is Red Clover. Mammoth, or Medium, Clover is often sown, but is much less common than the preceding. Alsike Clover is becoming more common. Two sweet clovers are not infrequent; the White Sweet Clover is more abundant than the yellow. Crimson Clover has been tried repeatedly, but is not adapted to Iowa conditions. It suffers much from drought in late summer, and from insect and fungus enemies.

Many native species of grasses occur, and they vary in quantity and quality in different sections of the State. The dominant grasses of central Iowa are Little Blue-Stem and Big Blue-Stem. Both of these species are frequently called Blue-Joints. Several species of *Elymus* are abundant, as Wild Rye, on the prairies and meadows; Lyme-grass on the flood plains of streams, and Dennett-grass along the borders of woods. Other common grasses are: Indian Beard-grass, or Bushy Blue-Stem, in prairies and open woods; Tall Grama-grass of the dry prairies and gravelly knolls; Nodding Fescue in woods; Slender Fescue in dry sterile soils; Short's Fescue in low prairies, a most valuable species; Switch-grass in rather moist meadows; Satin-grasses (*Muhlenbergia racemosa*, *M. diffusa*, *M. willdenovii*, and *M. mexicana*) in moist

soil of open woodlands and meadows; Swamp Chess in open woodlands; Fowl Meadow-grass in low grounds along streams; Wire-grass and Squirrel-tail-grass, an introduced species, in meadows and waste places; Blue-Joint, Reed Canary-grass, Common Reed-grass, and Floating Manna-grass in marshy places and shallow water; Large Rush-grass and Bunch-grass in dry prairies. In northwestern and western Iowa the above as well as some additional species occur. Among the latter are Western Wheat-grass, Bearded Wheat-grass, Blue Grama, Slough-grass, and Big Sand-grass.

The most widely distributed of all the native leguminous plants is Canadian Rattle-weed (*Astragalus canadensis*), a thrifty, hardy, and vigorous species found in woods, low meadows, and prairies. It is eaten by stock, but becomes rather woody when old. Buffalo Pea, or Ground Plum, is common on dry sterile hills throughout the region and affords valuable forage. American vetch is one of the most valuable of the native legumes. It grows in the moist soil of low prairies and open woodlands. This vetch is well adapted to the conditions of western and northwestern Iowa, and does well under cultivation. The prairie clovers (*Petalostemon violaceus* Michx., and *P. candidus* Michx.) are common on the prairies everywhere, as also on the loess soils of western Iowa. These plants are seldom eaten by stock unless forage is scant. *Dalea alopecuroides* Willd. is common throughout the loess region and has been introduced farther eastward. Wild vetch, well known as a valuable forage plant of the Northwest, is indigenous to the loess, though not abundant except locally. It has been introduced into Boone County. Running Buffalo clover (*Trifolium stoloniferum* Muhl.), a native, is considered a valuable forage plant by the farmers of western Iowa, and is worthy of a trial under cultivation. Mention should also be made of a Loco plant (*Oxytropis lambertii* Pursh.) native to this region. Though often consumed by stock, no complaints have been made that it produces loco poisoning. Rattlebox (*Crotalaria sagittalis* L.) occurs in the more sandy bottoms of the Missouri River. Complaints have frequently been made of the trouble it causes when fed to horses. The disease it produces has been called "crotalism."

OBSTACLES IN THE WAY OF GROWING NATIVE FORAGE PLANTS.

There are some serious obstacles in the way of maintaining the native meadows and pastures of Iowa. These may be classed under two heads—the overstocking of pastures and the growth of weeds. Many farmers attempt to raise more stock than their pastures will safely accommodate. The grasses can not endure the close grazing and excessive trampling to which they are subjected, and consequently they die out. Snow in this section of the State is usually blown from the open fields soon after falling, and hence can not be depended upon to protect the grass roots in pastures that have been too closely grazed. As a result of this, weedy annuals, like Southern Poverty-grass, Foxtail and Squirreltail spring up to take the place of the better perennial

species, or the native ragweeds and verbenas spread and occupy the soil. All of these have become so plentiful that farmers remark on their more frequent occurrence now than in former years. Several rank-growing weeds are abundant in meadows and pastures of western Iowa. Sunflower and Marsh Elder find in the rich alluvial soil of the river bottoms a most congenial place for their development. They are especially troublesome on land that is often flooded during spring freshets. It may be that farmers of this region who rely chiefly on the hay crop will be obliged to introduce better turf-forming grasses, such as can resist the inroads of these weeds. From what I have seen of Blue-grass in this region it may prove a good grass for this purpose and Hungarian Brome (*Bromus inermis*) may prove to be of even greater value. Snow-on-the-Mountain (*Euphorbia marginata*), a well-known ornamental plant, is a serious pest in western and northwestern Iowa. Golden Rods are often troublesome in pastures, especially *Solidago canadensis* and *S. rigida*. Stock will not eat them unless forced to do so, and when once well established in the pasture they are very difficult to eradicate.

NEBRASKA.

THE FORAGE PROBLEM.

The forage problem of Nebraska is one of peculiar interest. A great variety of native species occur because of the diversified climate and soils of the State. Observations were made in the vicinity of Omaha and thence southwest to Lincoln, Crete, Hastings, and McCook to the Colorado line. The rich, fertile bottoms along the Missouri, the rolling prairie west of Omaha, the fertile valleys of the Platte, Salt, and Blue rivers, the salt marshes in the vicinity of Lincoln, the vast stretch of level prairie about Hastings, the flood plain of the Republican River, with the rolling clay hills that rise from this valley, the narrow canyons, and the sand hills in the western part of the State are striking illustrations of the varied features of this region. Grazing is now, and ever will be, an important industry in the western half of the State. Although the grasses may not grow so luxuriantly season after season in Nebraska as in Iowa, the climate is more favorable for winter grazing than in the latter State, and there is a large number of valuable species of native forage plants.

NATIVE GRASSES.

It will not be necessary to discuss the forage plants of eastern Nebraska, as the conditions are similar to those in Western Iowa, and the foregoing remarks will apply to this region.

In the central and western parts of the State the farmer relies chiefly on the native forage plants. I was unable to find a single introduced grass superior to Grama-grass, Wild Wheat, Turkey-foot, Big Blue-Stem, and Buffalo-grass. I was strongly impressed with the fact that the grasses best adapted to this climate are the native species. In

alluding to the value of our native grasses to obtain improved forms, Prof. F. Lamson-Scribner says:

Nearly all of our cultivated forage plants are of foreign origin, and if it were not simply a matter of public interest, it ought to be one of public sentiment to preserve for the coming generations of American farmers these native species which have added so much to the wealth of the land in the past. The species in the grazing regions in the west and southwest, and for that matter, in every part of this country where sheep or cattle are raised, are best adapted for the conditions under which each grass grows, and it is folly to think that better forms may be introduced from Europe or Asia or Australia, where climate and soil and abundance of rainfall are different. The meadow grasses of the parks, woodlands, and mountain slopes, the Grama and Buffalo grasses of the southwest and the Blue-stems of the eastern prairie belt, can not be improved upon.

It certainly seems to me that the time has arrived for us to consider the advisability of saving from extermination the numerous valuable forage plants found in the arid and subarid portions of our country. The long-continued existence of these grasses shows that they are adapted to the climate in which they occur. For ages these valuable grasses have defied unfavorable climatic conditions and have stood the tramping and grazing of vast herds of buffaloes.

Central Nebraska is very favorably situated for grazing. The soil in this section is productive, as is evidenced by the fine crops of corn and small grain which have been grown here under favorable climatic conditions. Influenced by these fine crops, settlers occupied the country and the valuable native turf was turned under and the land devoted to the growth of small cereals and corn. The results in many instances have been anything but satisfactory. No method of agriculture or human agency can control weather. The ordinary cultivated crops can not be produced with a scant rainfall. The semiarid belt is superb as a grazing country, unexcelled west of the Missouri. A crop of grass is just as certain here as corn is in eastern Nebraska. The climate is favorable for winter grazing and stock will need little attention. The crop can not be as large as under conditions of greater moisture, and the grazing lands must be kept under certain restrictions. Business men and intelligent farmers with whom I have conversed believe that the only salvation for this region is the stock industry. It will take some years to again see the turf-forming grasses cover the field where the plow has destroyed the sod which was many seasons in forming. Some believe that they will never return. It requires time to reestablish a prairie, just as it does a forest, when once burned over, to become covered with trees again. Annuals appear first, some nearly worthless, but these prepare the way for the better perennials, like Blue-Stem and Grama.

COLORADO.

CENTRAL AND NORTHERN COLORADO.

The conditions prevailing in central and northern Colorado are so different that the subject can not well be discussed under one head. In northeastern Colorado the conditions are much the same as in west-

ern Nebraska. In the semiarid regions considerable areas were at one time cultivated, but, after a few years of unsuccessful attempts at raising corn, oats, and wheat, the land has been allowed to revert to grass. The several branches of the Republican River rise in the sand-hill region of eastern Colorado. This section of the State has become famous as a stock country and is seemingly prosperous. Nearly every farmer is provided with a neat house. Windmills are numerous for the purpose of providing water for the stock. The country to the north, drained by the Platte, is likewise largely devoted to the cattle industry. The most conspicuous grasses are considered in detail elsewhere in this paper. Though the rainfall is limited, there are thousands of acres of fine meadows and grazing lands covered with a dense growth of Gramagrass. In some places this grass would yield a ton of hay to the acre.

FORAGE CONDITIONS OF THE PRAIRIES AND SAND HILLS.

Turkey-foot-grass, or Big Blue-Stem, 4 to 5 feet high, grows very luxuriantly over the sand hills. Western Wheat-grass, from 2 to 3 feet high, grows on the open prairies where not pastured. The year 1896 was certainly most favorable for the growth of these wild grasses. Such a season demonstrates what this region can do in the way of grass production. In Washington County, in the vicinity of Akron, with a higher altitude than at Robb, Wray, and Yuma, the ranges were in excellent condition, though not as good as in the sand-hill region. In the vicinity of Fort Morgan the range conditions were not so good; there was less rainfall and the grasses were closely cropped. Still the region afforded some good grazing, consisting chiefly of Blue-Stem, Indian Millet, Western Wheat-grass, Blue-Grama, Buffalo-grass, Wild Rye, Feather Bunch-grass, and Needle-grass.

In the country surrounding Fort Morgan the ranges are chiefly used for sheep raising. Along the Platte to the east and west are several large irrigation ditches. The chief forage plant grown here is alfalfa. Too much praise can not be given to this plant. There are thousands of acres of it. Three crops are cut in a season, and the hay brings from \$3.50 to \$4 a ton. In many cases the farmers allow their sheep to run on the range in the summer and in the winter feed them on alfalfa hay.

Greeley and Fort Collins in northern Colorado are famous for the large areas under irrigation. Some of the most valuable irrigated lands of the State are located here. The principal streams supplying water for irrigation are the Platte, Cache la Poudre, Big Thompson, Clear Creek, and Boulder Creek. Here, as elsewhere east of the mountains, alfalfa is one of the chief crops. At several points dairying is an important industry, and the fattening of sheep and cattle on alfalfa is assuming considerable importance. The fact that alfalfa is a bulky crop makes it more profitable to ship cattle to points where this crop is grown than to ship the fodder great distances. It would seem, however, that Colorado can not at present produce enough alfalfa to supply

her own demands. A great deal of range stock is shipped out to be fattened in Iowa, Nebraska, and other States.

Three Brome grasses are becoming established in the vicinity of the Colorado Agricultural College. Two of these, Hungarian Brome (*Bromus inermis* L.) and Rescue-grass (*Bromus unioloides* Willd.), are valuable forage plants. The third (*Bromus tectorum*) is a weedy annual on the grounds of the experiment station. Many of the cultivated species such as Timothy, Redtop, Blue-grass, and Orchard-grass, are naturalized in many places, but farmers, as a rule, do not make a business of growing these grasses, as they do not thrive without irrigation. Alfalfa occasionally grows where the soil has not been irrigated for a season, but the growth is so poor that it is often not worth the cutting. Several other leguminous plants are common. White Sweet Clover is a weed in many of the irrigated districts. Yellow Sweet Clover is less common than the White. Neither of these, so far as could be learned, is used for forage.

A large number of native grasses occur along irrigating ditches and streams, and many of them are highly nutritious. One of the most conspicuous is Slender Wheat-grass, which grows to a height of 3 to 4 feet and produces a large number of leaves. The Western Wheat-grass is also much more productive in such situations than in high and dry soil. Feather Bunch-grass grows luxuriantly. Wild Rye is a large and coarse grass of little value when compared with many of the other species noted here. In low, swampy places Slough-grass grows from 1 to 4 feet high, and makes fine hay. *Polypogon monspeliensis* Desf., a weedy annual, also occurs along irrigating ditches. *Catabrosa aquatica* is an aquatic grass of irrigating ditches and wet canyons in the foothills. These have been disseminated on the plains by water brought from the mountains. Macoun's Rye-grass (*Elymus macounii* Vasey) occurs in the flats along the river courses. Cord-grass occurs in low ground and Slender Cord-grass is sparsely represented in alkaline marshes. Fowl Meadow-grass is abundant in the fields in the vicinity of Fort Collins and Golden. Squirrel-tail-grass is plentiful in seepage meadows and is a noxious weed when the bearded "heads" have formed, though it is of some value when young. The common Reed-grass occurs in quantity in the low meadows, but it is of little agricultural value. The marshes contain numerous sedges and rushes, as *Carex maricida*, *C. ajuncis*, *Scirpus lacustris*, and others. Several species of *Juncus* are also common.

GRASSES AND FORAGE PLANTS OF THE FOOTHILLS AND MOUNTAINS.

The foothills, as well as the higher mountain slopes, produce a large number of valuable grasses. The grass flora is not equally rich throughout, that of the higher altitudes being more varied and richer as to species and quantity. The low foothills which rise from the prairies have many species in common with the prairies. It is only in the

canyons that one meets the larger and less common grasses. The grasses of the dry foothills generally grow in small bunches, but they are surprisingly nutritious. Notwithstanding the dry weather prevailing in the foothills during the month of June, 1896, cattle were in most excellent condition, which indicated that they had been fed on forage of superior quality. The conditions are such as one occasionally finds in the case of Blue-grass during a dry season in the Eastern States, the leaves of the grasses, though perfectly dry, containing an abundance of nutriment. In the narrow canyons and wider valleys a more luxuriant growth was observed, and where stock were not allowed to graze the meadows were in fine condition. The larger valleys up in the mountains are mostly taken up by homesteaders, who select this land since they can here raise a crop of two-rowed barley. This barley is cut and used for hay. The larger wild grasses growing in these meadows are used in a similar way. During the summer the cattle range on the mountains, and in the winter are fed on the hay made in the valleys. Not only do ranchmen grow cattle for beef, but at the lower altitudes dairying is carried on and the butter made finds a ready sale in the mountain towns.

In the lower foothills large areas of pine and Douglass spruce have been to a great extent removed. Several small shrubs, such as Nine-bark (*Physocarpus torreyi*), Raspberry (*Rubus deliciosus*), *Purshia tridentata*, and *Jamesia americana*, are common. *Purshia tridentata* is frequently browsed by cattle; in fact many of the plants are picked bare. The chief pine at lower altitudes is *Pinus ponderosus scopulorum*. When not too dense, these woods furnish excellent grazing. At higher altitudes, about 8,500 feet, *Pinus ponderosus* is the principal tree. The woods are usually open enough to allow a growth of grass underneath, and make good ranges, especially since there are numerous small openings, where species adapted to moist soils grow. It has frequently been stated that the burning of these forests is conducive to a good growth of grass. This is true only in mountain meadows. A forest burnt over is absolutely sterile for a term of years, as far as forage plants are concerned. The fire not only destroys whatever turf there is, but it prevents reseeding. Such burnt forests are at first largely covered with various fireweeds, which are of little or no value for forage. In the course of years the character of vegetation changes; grasses and little shrubs appear, then the Trembling Aspen (*Populus tremuloides*) comes up; it soon becomes so thick that but little else will grow, and cattle find little pasturage. A fire, therefore, destroys for a period of years all hope of good forage, and it is to the interest of the ranchman that the forest should not be burnt over. The grasses most suited for these regions are such as are indigenous here; in fact there are few evidences of naturalization. Timothy is not uncommon in the foothills, but was found in only one locality at an altitude of 10,000 feet, along one of the mountain trails. White Clover was also found at nearly the same altitude under similar conditions.

The mountains are marked by extremes of temperature. Early in July, at an altitude of 8,500 feet, it is not uncommon to have the thermometer fall to 40° F. during the night. On the Little Beaver, one of the small mountain streams that finds its way into the south branch of the Cache la Poudre, at an altitude of 9,500 feet, the thermometer registered 38° F. in the morning, and yet at noon, in an open meadow, it was 110° F., most uncomfortably hot. Under such conditions Buffalo Bunch-grass grows to magnificent proportions. Western Bromegrass and Swamp Chess formed large patches. The little Mountain Timothy grows in large masses in the moister woods below. Few of our cultivated grasses can grow under such changeable conditions without losing vitality. At an altitude of 8,500 feet, lower down on Beaver Creek, barley made a poor growth. It was scarcely 6 inches tall, while Buffalo Bunch-grass was not only in flower at 9,500 feet, but seed was forming. How much better to have started a meadow of this bunch-grass than to sow barley every spring.

Three indigenous clovers (*Trifolium nanum*, *T. parryii*, and *T. dasyphyllum*) occur in northern Colorado. The first is a dwarf species of Pikes Peak at and above timber line. The two larger species cover the ground in perfect mats, and are valuable forage plants. Our horses fed on these clovers in preference to the grasses and sedges growing in the vicinity.

CHEMICAL COMPOSITION OF SOME COLORADO FORAGE PLANTS.

The chemical composition of a few Colorado grasses from chemical analyses made at the Colorado Agricultural Experiment Station is as follows:

Analyses of some Colorado grasses.

Grasses.	Water.	Ash.	Fat.	Albumi- noid nitrogen.	Crude fiber.	Nitrogen- free extract.
Grama grass (<i>Bouteloua oligostachya</i>).....	7.33	7.31	1.73	7.51	14.62	68.33
Buffalo grass (<i>Bulbils dactyloides</i>)	7.80	10.33	2.25	7.54	14.59	65.29
Western Wheat grass (<i>Agropyron spicatum</i>)...	7.91	7.09	2.57	7.32	19.65	63.37
Slender Wheat-grass (<i>Agropyron tenerum</i>)....	7.86	6.28	2.04	6.15	20.20	65.33
Prairie June grass (<i>Koeleria cristata</i>).....	8.15	7.96	3.93	6.85	22.58	58.68
Mountain Timothy (<i>Phleum alpinum</i>)	7.87	6.30	2.60	10.67	16.91	63.52
Slough-grass (<i>Beckmannia erucaformis</i>)	8.36	6.21	3.05	8.53	22.65	59.56
Lupine (<i>Lupinus plattensis</i>)	9.87	9.17	1.98	13.68	17.93	57.24
Alfalfa (<i>Medicago sativa</i>)	10.92	17.27	7.69	8.00	16.16	58.88
Bokhara Clover (<i>Melilotus alba</i>)	8.75	7.39	3.65	17.85	14.04	57.07

The above analyses show that these native grasses vary considerably in composition, but that they compare very favorably with cultivated ones.

The forage problems awaiting solution are numerous, and the farmers and stock men are just beginning to realize the importance of work along these lines. It has frequently been urged by the Chief of the Division of Agrostology that more exact and definite data on many of our wild grasses and more experimental work in the improvement of the native grasses are needed. If by selection from the native

grasses an improved form of Western Wheat-grass or Grama grass can be introduced into the "semi-arid" region which will give greater returns than those already there, the live-stock industry will be put on a better basis and its success assured.

LIST OF THE MORE IMPORTANT GRASSES AND FORAGE PLANTS OF IOWA, NEBRASKA, AND COLORADO, WITH ECONOMIC NOTES.

Alfalfa (*Medicago sativa*) (fig. 1): This valuable legume is spontaneous only in the most favored places in central Iowa, but is



FIG. 1.—Alfalfa (*Medicago sativa*): a, seed pod seen from the side; b, seed pod seen from above; c, seeds.

more frequent from Carroll west, especially in the loess soil along the Missouri. The fact that it persists for some years is evidence of adaptability. As a cultivated plant, it has met with moderate success in a few places in Carroll, Audubon, Monona, Woodbury, Pottawattamie, and Harrison counties. I saw several good-sized fields in the Missouri River bottom, near Sargent's Bluff, in Woodbury County. The first crop was ready to cut by the 18th of June. The Missouri bottoms are favorable to the growth of alfalfa because permanent water is reached at a depth of 10 to 12 feet. The only difficulty in the way is that these bottoms are subject to overflows; the water during some seasons

stands for days on the soil in low places. It is possible that the higher locations might be admirably suited for the growth of this crop. In fact, good crops were observed on the higher lands. The soil of the bluffs along the Missouri is commonly known as "loess." It is not peculiar to western Iowa, but occurs abundantly along the Mississippi and other Iowa streams. Loess is a fine homogeneous soil, free from pebbles or other adventitious matter, very friable, so much so that it may be turned with the spade. It stoutly resists weathering, and stands in vertical faces for years. Though the surface dries quickly, this soil retains water in a remarkable manner.

These loess bluffs rise rather abruptly from the rich and fertile Missouri bottoms and extend as undulating hills for several miles east. In this region, which is comparatively narrow, a peculiar vegetation exists, peculiar at least for the State of Iowa. It is more western than eastern. It is here that alfalfa has succeeded best, and is perhaps destined to play an important part in the agriculture of the counties bordering on the Missouri. There are some difficulties to contend with in Carroll and Harrison counties, and this is true also to some extent in Pottawattamie County. The humidity of the atmosphere is somewhat greater than in Woodbury County. Accompanying this humidity there is a greater rainfall, and a greater rainfall makes the plant more subject to the attacks of the Spot Disease (*Phacidium medicaginis*). This fungus disease causes a premature falling of the leaves, and hence lessens its value as a forage plant.

Alfalfa is the most valuable acquisition to the leguminous forage plants of Nebraska. The frequency of naturalized specimens throughout the region in which I made observations certainly indicates that the plant is at home. Fine fields of it were observed not only in the lowlands along the Republican Valley, but also on the uplands. Its culture, however, was most successful on the flood plains of the river and under irrigation. It produces a fair crop without irrigation some years, but on the uplands, year after year, it can not be depended on. In the Republican River Valley the water level is from 8 to 10 feet below the surface. The roots easily reach this depth. Under favorable conditions three crops can be cut in a single season, but where the field is irrigated three crops are certain, and I was informed that it affords almost twice as much money return per acre as corn. A farmer with 40 acres of irrigated alfalfa can make a comfortable living in this part of the State. In the country east of the semiarid region considerable alfalfa has been grown, and, so far as I was able to learn, with good success. No other perennial forage plant has given to the farmer of this region the same amount of satisfaction as has alfalfa. It is certainly destined to play an important part in the forage problem in Nebraska.

Alsike Clover (*Trifolium hybridum*) is occasionally grown in Iowa, but is not as yet common. It is spontaneous in many places and is best suited for rather low grounds, frequently associated with White Clover and Red-top. It will probably never take the place of Red or White Clover in the State.

Barnyard grass (*Panicum crus-galli*). This grass, although usually regarded as a weed, is frequently used as a forage plant in western Iowa. It occurs abundantly as a roadside and garden weed in central Iowa, and is a conspicuous grass in sloughs and in corn-fields in the Missouri bottoms. Hundreds of tons of this grass

might have been cut in Iowa this year. It is not always so plentiful, since the rains are usually less frequent in July and August.

Bearded Wheat-grass (*Agropyron caninum* R. & S.) is common in northwestern Iowa. It contributes somewhat to the native hay, but is of little value. In Colorado it is also common, even at an altitude of 9,500 feet. It is not so large as Slender Wheat-grass and grows in drier places. A closely allied species, *A. richardsoni*

Schrad., occurs also in the mountains and compares favorably in forage value to *A. caninum*. Wire Bunch-grass (*A. divergens* Nees) is common in Clear Creek Canyon, near Golden, Colo., and is a grass of considerable value.

Big Blue-Stem (*Andropogon provincialis* Lam.) (fig. 2) is a common species throughout central and western Iowa. Wherever a bit of prairie remains this grass grows in abundance. It is a variable species, growing in bunches 3 to 8 feet high, and producing a large number of fine leaves. It occurs on the high, rolling prairie, rocky, open, wooded hill-sides, and along the alluvial creeks and river bottoms. Blue-Stem is an important factor in the wild hay made in the Missouri bottoms, especially in the northwestern part



FIG. 2.—Big Blue-Stem (*Andropogon provincialis*): a, a pair of spikelets; b, first empty glume; c, second empty glume; d, third glume; e, fourth or flowering glume; f, palea; g, lodicules.

of Iowa. It is liked by stock both as green forage and as hay. For horses many farmers prefer it to timothy. Blue-Stem hay brings a higher price in the market than any other wild hay. The grass was common about Lincoln, Nebr., and was observed as far west as McCook. It is a most excellent grass for the moister portions of the State, producing a large percentage of the wild hay as well as affording much of the pasturage. Near McCook, Nebr., it produced a fine growth in the flood plain along the Republican River. It requires a richer soil than the Turkey-foot grass.

Big Sand-grass (*Calamovilfa longifolia* Scribn.) is not common in central Iowa, though rather common in northwestern and western Iowa, where it abounds along railroads, on dry sterile soil, and steep hillsides. It often does good service in binding the loose soil together. As a forage plant it is of little value, the culms and leaves being very tough. In Nebraska it is common in the sand-hill country and also in the sandy marshes of the Republican Valley.

Black Grama (*Bouteloua hirsuta* Lag.) is common in the sand-hill region of western Nebraska. It forms dense tufts of fine leaves. It is nutritious, like the other gramas, and fills an important place on these poorer soils.

Blue Grama (*Bouteloua oligostachya* Torr.) (fig. 3) grows from 8 to 18 inches high, varying somewhat with seasons. It was much taller on the average in 1896 than in 1895. As a rule this grass seldom exceeds a foot in height. It is endowed by nature with great drought-resisting qualities. Around Crete and Lincoln, Nebr., it is common on dry soil and on gravelly knolls. At Hastings, Nebr., it is a dominant grass in meadows and pastures. The same may be said of it from McCook to the west line of Nebraska. As a pasture

grass it is excellent, being nutritious and standing trampling better than Western Wheat-grass. A few years of selection under cultivation would no doubt produce a form equal to many of our cultivated grasses. Stockmen inform me that cattle thrive on this grass all winter in western Nebraska. In Colorado it is common in the foothills, especially between 5,000 and 6,500 feet altitude. Some plants were seen on an open prairie in northern Colorado at an altitude of 7,000 feet. Near Golden it was likewise observed at an altitude of 7,000 feet. It is common also at Colorado Springs, north of



FIG. 3.—Blue Grama (*Bouteloua oligostachya*): a, empty glumes of a spikelet; b, spikelet with the empty glumes removed.

Cheyenne Canyon, at an altitude of 6,500 feet. It usually grows much shorter than at lower altitudes.

Blue-joint (*Calamagrostis canadensis* Beauv.) is plentiful in Iowa only in low swales and second bottoms, where it commonly grows from 3 to 4 feet high, forming an abundance of leaves, well liked by all kinds of stock. The leaves keep green till late in the season, and the hay is not objectionable because the leaves and culms are not dead at the time when hay is usually made, as is often the case with Wild Rye.

Broom-corn Millet (*Panicum miliaceum*) is seldom cultivated in the central district of Iowa, though used more extensively in northern and northwestern parts of the State. It does well in dry years, and as a productive crop should commend itself.

Buffalo Bunch-grass (*Festuca scabrella*). This species at higher altitudes is the bunch grass par excellence. It is abundant on the Little Beaver in northern Colorado, at an altitude of 9,500 feet, where it occurs in open, sunny places and grows from a foot to 4 feet in height. The blades are often a foot long. The whole plant is more or less glaucous, which adds to its striking appearance. Professor Crandall, who is familiar with the plants of this region, states that several years ago, when stock had not grazed so far up the mountains, this grass occurred in great quantity in the open, sunny places at an altitude of 9,500 feet. Very few good specimens could be found, because almost every blade had been closely cropped. The Rocky Mountain Husbandman has this to say of Bunch-grass:

The cured grass retains its nutriment all winter, owing to the fact that we have no drenching rains in the fall to bleach it—the light snows which come in early winter and melt off soon only serving to moisten it and make it more palatable. When we have late summer rains and the grass remains green until fall, should frost come early it is injured and stock do not seem to keep in such good condition during the winter as when it dries up early, as is generally the case. During the winter the lowlands and sharp foothills are for the most part free from snow. Usually the snow is cleared away by the wind except that which is driven into the thick clusters of grass. * * * In grazing the stock gather up more or less snow, which serves in great measure as a substitute for water. With the disappearance of snow in the spring, stock go up into the foothills, following the receding snow line. The grass which lies covered all winter is relished best. Besides, the young crop starts first and grows fastest among the steep hills.

What is here said of Buffalo Bunch-grass applies also to Montana and Idaho, where it grows at lower altitudes. This grass has received the same high appreciation by stockmen everywhere.

Buffalo-grass (*Bulbils dactyloides* Raf.) (fig. 4) once extended farther east than now, since it is reported from northwest Iowa. I did not, however, meet with it in that part of the State, nor did I observe it east of Lincoln, Nebr. At Lincoln small patches occur. It is abundant about Hastings, Nebr., where, in some cases at least, it is the chief pasture grass. It is common about Oxford and

McCook, Nebr., and westward to the Nebraska line, although at no point was it so finely developed as on the beautiful prairies surrounding Hastings. Buffalo-grass is certainly adapted to the semiarid belt and to the western part of the humid prairie region. Farmers agree that it is exceedingly valuable, not only because of its nutritious qualities, but the close turf retains the moisture and allows the plant to develop under conditions adverse to most plants, certainly to our cultivated grasses. Every effort should be made to retain this grass. In central and southwestern Nebraska it is not only a valuable summer forage, but the mild winters make it especially desirable for winter grazing. When used for this purpose it should not be cropped too closely in the summer. The farmer should recognize the importance of not overstocking the ranges. He should give this and other grasses time to produce seed, so that they may perpetuate themselves by seeds from the most vigorous plants. Buffalo-grass seeds freely, and this is one of the most important points in its favor. In Colorado I observed it only in the lower foothills, where it is a valuable grass. It grows in the same way as on the plains, forming large mats and patches of turf, which are closely cropped by stock.



FIG. 4.—Buffalo-grass (*Bulbilis dactyloides*): a, female plant; b, male plant; a', two clusters of female spikelets; b', a branch of several staminate spikelets; c, a male or staminate spikelet of two flowers.

Buffalo Pea (*Astragalus caryo-*

carpus Ker.) is common on the prairies of Nebraska and dry, sterile hills of central and western Iowa. It is valuable as a forage plant.

Bunch-grass (*Sporobolus heterolepis* Gray) is the most valuable of the several Drop-seed grasses that abound in central and western Iowa. This beautiful species occurs on high or low prairies and hillsides with Little Blue-Stem and Switch-grass. It grows in bunches and produces large numbers of slender leaves close to the ground.

Bunch Spear-grass (*Poa arida* Vasey) comes up quite abundantly in the meadows of arid pastures in the Republican River Valley, Nebraska. It somewhat resembles Blue-grass, with sharp-pointed

leaves and a more scant growth. It flowers early, and hence when hay is cut it is past its season.

Bushy Blue-Stem (*Andropogon nutans* L.) is a tall perennial found in open woods and prairies in Iowa and eastern Nebraska, but is less common than the other blue-stems. It is cut late in the season, usually in August or September, because then more easily made into hay. The hay is palatable and nutritious, and cures well.

Though the quantity would be less if cut by the middle of August, the quality would be superior.

California Oat-grass (*Danthonia californica*) is abundant in the pine woods and meadows of northern Colorado at an altitude of 8,000 feet. It grows in bunches from 1 to 3 feet high, has soft foliage, and is one of the valuable mountain grasses. It is much eaten by stock, and forms a considerable element in the forage of the mountain "parks" and meadows.

Colorado Blue-Stem (*Agropyron spicatum*) is one of the two valuable grasses of this genus that are native to Iowa. It is common on the loess in western Iowa, where it is used for both hay and pasturage. As an introduced plant it is now common at many points



FIG. 5.—Fresh-water Cord-grass (*Spartina cynosuroides*): a, spikelet showing three stamens; b, spikelet showing the projecting stigmas of the pistil; c, the same with the outer glumes removed.

in central Iowa and is spreading rapidly. In Iowa it grows more vigorously than it does in Nebraska, where it attains a height from 2 to 4 feet. It is bluish green in color, with somewhat harsh leaves. The thriftiness of this grass in new meadows as well as in the vicinity of plowed ground indicates that an occasional stirring is beneficial. I am assured that it is not difficult to start a good meadow of this grass in two or three years on plowed ground. It

grows along with such grasses as grama and other prairie species. Meadows of considerable extent occur between Crete and Hastings, Nebr. It is quite a novelty to see hundreds of acres with the conspicuous blue-green color of this grass. It is common in the foothills in central and northern Colorado, and about Golden and Colorado Springs. It is not uncommon in open places at an altitude of 7,000 feet, but is much more abundant at 5,000 and 6,000 feet.

Cord-grass (*Spartina cynosuroides* Willd.) (fig. 5) is abundant in low grounds, and is an important feature of the meadows in western Iowa along the Missouri. It is well suited for the alluvial soils of this region, and can endure standing water better than Big Blue-Stem. Nature has adapted Cord-grass to low and swampy places. The reserve material stored in the root stocks enables it to grow rapidly when the water has receded. Many farmers hold this grass in high esteem. One farmer informed me that it was more valuable than Big Blue-Stem. For the Missouri River region it is a most profitable grass. In Nebraska it is common in low grounds from Omaha to McCook. It is of little value as a pasture grass, and is commonly cut for early hay.

Couch-grass (*Agropyron repens* Beauv.) is naturalized in many places in Iowa, and is often cut for hay. It starts early in the spring and produces a large number of fine leaves. In frequent rotations it is a pest rather than a valuable forage plant. In soils much subject to wash it has proved of value as a soil binder. It occurs as an introduced plant in Nebraska about Omaha and at McCook, but is much inferior to its western relative.

Crab-grass (*Panicum sanguinale* L.) is abundant throughout Iowa in cultivated fields and open places in blue-grass pastures. Usually regarded as a weed, but may afford some picking in cornfields after corn is removed. Under such conditions, however, the forage is of poor quality.

Downy Oat-grass (*Trisetum subspicatum*) is abundant in Colorado in dry open woods and open places. It is one of the first grasses to appear after fires have swept the forests.

Early Bunch-grass (*Eatonia obtusata*) grows in rather moist prairies throughout Nebraska. It matures early and produces only a small quantity of leaf and stem, and hence is not as important a factor in the production of either hay or green forage as is Prairie June-grass.

Feather Bunch-grass (*Stipa viridula* Trin.), although not indigenous to central Iowa, has been found spontaneous along the railroad west of Ames. It grows in bunches, seeds freely, and is much more palatable than Porcupine-grass. It might be introduced with advantage on the loess soils of western Iowa. In Nebraska it was observed in considerable quantity on the second bottom along the

Republican River and on the upland prairies. It is less objectionable on account of its "spears" than Porcupine-grass and Needle-grass. The leaves are softer and retain their nutritious qualities longer. It is well adapted to this section of Nebraska. In Colorado it is abundant, not only at an elevation of 5,000 feet in the vicinity of Fort Collins, but near Colorado Springs and Golden it abounds up to an altitude of 8,000 feet. It is one of the most valuable forage plants of the foothills.



FIG. 6.—Hungarian Brome-grass (*Bromus inermis*): a, spikelet; b, flowering glume seen from the back; c, floret seen from the anterior side, showing palea.

Fowl Meadow-grass (*Poa flava*) is not uncommon on the flats and along the smaller streams in western and northwestern Iowa. It would be of greater value for hay if it could be harvested earlier. Under present conditions of making hay in August it has lost much of its valuable qualities. In Colorado this species occurs in wet grounds at lower altitudes than Blue-grass.

Foxtail or Pigeon-grasses (*Chenopodium viridis* S. & S. and *C. glauca* S. & S.) are abundant throughout central and western Iowa in cultivated fields and in open places in Blue-grass pastures. Though usually regarded as weeds, they afford some picking in cornfields after the corn is removed. Under

these conditions, however, the forage is of very poor quality.

Giant Rye-grass (*Elymus condensatus*) is abundant in Colorado, at an elevation of 5,000 to 5,500 feet. Cattle seem to prefer the shorter grasses to this large coarse species. Professor Lamson-Scribner speaks of it as an excellent winter forage plant in California. A second species (*Elymus triticoides*) was observed in spruce and pine woods in Clear Creek Canyon. It is of some value in the sparsely wooded areas of this region of Colorado.

Hungarian or Smooth Brome (*Bromus inermis* Leyss.) (fig. 6) withstands drought and cold, and is perfectly adapted to conditions existing in Iowa. It makes excellent growth and more nearly reaches the ideal of a farmer's grass than any other sort introduced in recent years. Under favorable conditions two crops can be cut in a single season, and the aftermath is excellent. Hungarian Brome commends itself to the farmers of central and western Iowa. This is the Russian grass or Russian Brome-grass of some writers.

Kentucky Blue-grass (*Poa pratensis* L.) (fig. 7) is the chief pasture grass of central and western Iowa, though not so prominent in northwestern Iowa. It does fully as well in and about Jefferson, Carroll, and Logan as in northeastern, southwestern, and southern Iowa. Southwestern Iowa has sometimes been called the Blue-grass region of the State. The spring of 1896 in central Iowa was early, and in many cases cattle were turned into the pastures before the 1st of May, from which time to the 15th of July this grass is generally at its best. Although checked by a short mid-summer drought, a vigorous growth was induced by rains in the latter part of July, so that during August and September pastures looked as green as they did in May. It is not uncommon for many farmers to feed in August, but the excellent condition of the grass pasture rendered this entirely unnecessary in 1896.

In 1895, and especially 1894, because of the great drought in Iowa, many farmers fed green corn fodder in August. Blue-grass can not, therefore, be depended on every season, but it is reliable and safe as a pasture grass most seasons. Green corn fodder is a safe sub-



FIG. 7.—Kentucky Blue-grass (*Poa pratensis*): a, a spikelet; b, the floret, showing the hairs or wool at the base.

stitute, and every farmer should have some corn which can be used to feed in July and August when necessary. Some farmers in central Iowa advocate the more extended use of corn fodder for this purpose. They believe that less area should be devoted to the grass pasture. A Blue-grass turf is a producer of wealth, and if properly managed increases in importance as the country becomes older. Short rotation is not advised, though many farmers get excellent results by planting Blue-grass seed in the cornfields. In the spring of 1895, and especially the fall of 1894, many farmers were disheartened because of the many vacant spots left in the pastures. These were soon occupied by Squirrel-tail grass, or Wild Barley, and Pepper-grass (*Lepidium apetalum* Willd.). These pastures have entirely recovered during the past season.

The subject of Blue-grass should not be passed without saying something of its use in the central section of the State as a winter forage plant. When speaking of winter pasturage in Iowa, the farmer refers to Blue-grass. It is a well-known fact that cattle do remarkably well on this grass in the winter. Though it has lost in nutritive qualities, it is highly relished and serves a most excellent purpose in keeping the digestive organs of the animal in good condition. With a good winter pasture of Blue-grass it will be unnecessary to use the "stock foods" to regulate the organs of secretion. Farmers should not lose sight of the fact that overstocking is injurious. To be in good condition for the winter it should not be overstocked in September and October. Other grasses have been tried in this way. Texas Blue-grass has received considerable notoriety in this respect, and while perfectly hardy at Ames, Iowa, nothing can be said about its use in central Iowa for this purpose, since it has not been extensively tried.

The composition of winter-grown and summer-grown Blue-grass, according to analyses made at the Iowa Experiment Station by Prof. G. E. Patrick and Mr. C. M. Wade, is as follows:

Analyses of winter-grown and summer-grown Blue-grass.

Constituents.	Winter-grown Blue-grass.		Spring and summer grown Blue-grass.		
	3 to 7 inches high, gathered Nov. 24, 1890.		3 to 6 inches high, gathered Apr. 28, 1890.	Early bloom, gathered July 28, 1890.	Just after bloom, gathered June 7, 1890.
	Green.	Dried.	Green.	Green.	Green.
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Water	61.73	23.05	68.05	62.91	61.24
Dry substance	38.27	76.95	31.95	37.09	38.76
Dry substance:					
Ash	9.32	12.41	11.49	8.47	8.66
Fat	4.69	4.24	5.55	2.25	2.75
Nitrogen-free extract or carbohydrates	51.49	48.40	42.74	50.50	50.79
Fiber	19.61	26.56	22.19	29.11	29.92
Protein	14.89	8.39	18.03	9.67	7.88

In eastern Nebraska Blue-grass is a success, thriving best on low grounds along rivers, but also giving good returns on the drier uplands. The season of 1895 was unfavorable for it in central Nebraska, but in 1896 the pastures were in excellent condition. The species was observed at Hastings and McCook. In the latter place it occurred in the streets and also in the flood plain of the Republican River. One of the finest Blue-grass lawns I have ever seen was noticed in Oxford. This was, of course, under irrigation. In the mountains of Colorado it forms an excellent turf. The meadows were as green as any in Iowa in May.

Large Rush-grass (*Sporobolus hookeri* Trin.), which is found on poorer soil than Bunch-grass, forms a dense turf. The leaves and stems are tough and wiry, detracting from its value as a forage plant. *Sporobolus cryptandrus* Gray is an earlier grass, likewise somewhat tough when old, not so common as Bunch-grass or large Rush-grass. *Sporobolus brevifolius* is one of the commonest grasses of the loess of western Iowa. It forms a dense mat of interlacing roots and root stocks, effectually preventing the washing of the soils. It also occurs near Carroll, Iowa. The species is of little value as a forage plant. Another species of this genus is common throughout this section of Iowa—Southern Poverty-grass (*S. vaginæflorus*). It occurs in fields and along roadsides, and is usually avoided by stock. During the dry seasons of 1894 and 1895 farmers complained of its presence in pastures.

Little Blue-Stem (*Andropogon scoparius* Michx.) is common in central and western Iowa. It grows on the poorer sandy soils, although in western Iowa it occurs abundantly on the loess bluffs, constituting a large share of the natural forage. It has the habit of forming bunches, and grows from 2 to 3 feet high, with a large number of root and stem leaves. It seeds more freely than Big Blue-Stem. Stock will eat the grass when it is young and fresh, but when old it becomes woody and unpalatable. It is common on the loess of eastern Nebraska about Omaha, and was also observed about Lincoln and Crete.

Loco Weed (*Oxytropis lambertii*) is of no value as a forage plant. Although the plant was common everywhere in Nebraska, I heard no complaints about it. In Colorado it is the most conspicuous and common of the *Leguminosæ*, but it is seldom eaten by stock.

Lupinus plattensis Watson occurs in sandy bottoms along the Republican River in Nebraska. It showed evidence of having been eaten by stock.

Manna grasses (*Panicularia* species). Several species occur in Iowa. *P. nervata* and *P. aquatica* are most common. These species are of value only in wet meadows and pastures.

Meadow grasses (*Poa* species) are common throughout the mountains of Colorado. At higher altitudes and lower down in moist

canyons Wood Meadow-grass (*Poa nemoralis*) is abundant, as is Bunch Red-top (*Poa buckleyana* Nash). These species are not so valuable as *Poa wolffii* Scribner, which is common in dry woods in Clear Creek Canyon, where it is one of the more important grasses. *Poa lettermannii* is common above timber line on Pikes Peak. *Poa rupestris* is likewise common. These poas constitute some of the most valuable grasses in all of the mountain meadows. *Poa*

wheeleri Vasey is another valuable grass of this genus found at an altitude of 7,800 feet. Mountain Spear-grass (*P. alpina*), at an altitude of 10,000 feet to timber line, forms a large cluster of leaves close to the ground.

Millets (*Chenopodium italica* and var. *germanica*). No other grasses are so productive on Iowa soil as the millets. Some farmers sow these grasses every year. As a rule, however, they are sown as "catch crops" in the latter part of June or early July, when by September a good crop of hay can be made. Some farmers are prejudiced against the millets because of the danger to stock when consuming large quantities of seed. When rightly managed, there need be little danger from this source. Millets are extensively grown in both eastern and western Nebraska. They do well in nearly all parts of the State. Fine fields were noted near Omaha, Crete, and

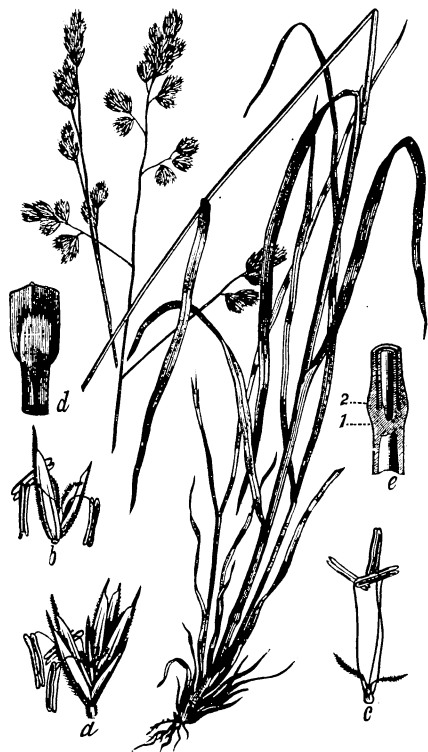


FIG. 8.—Orchard-grass (*Dactylis glomerata*): a, a spikelet with one of the florets expanded in flower; b, the floret; c, the flower, consisting of three stamens and pistil with two feathery stigmas; d, the upper portion of the leaf sheath and the lower portion of the leaf blade, showing ligule; e, section of the stem or culm at one of the nodes; 1, node proper; 2, the swelling enlargement of the basal portion of the leaf sheath.

Hastings, and also near McCook, at an altitude of 2,500 feet.

Needle-grass (*Stipa comata* Trin. & Rupr.) is common in Nebraska about McCook and westward, at an altitude of 2,500 to 3,000 feet. This grass grows on the high prairies. It is of forage value only under the same conditions as Porecupine-grass. In Colorado it is common in places in the foothills about Golden, Fort Collins, and Colorado Springs. It is not so valuable as Feather Bunch-grass, but adds to the list of plants available for forage purposes.

Orchard-grass (*Dactylis glomerata* L.) (fig. 8), though well known as a valuable grass, is seldom sown. Few farmers in this section of the State are acquainted with it. It is not uncommon along roadsides and in dooryards, giving evidence of adaptability to soil and climate. Although not generally cultivated in Nebraska, it is of frequent occurrence about Omaha, Lincoln, Crete, Hastings, and McCook. In all of these places it grows without irrigation, and the fact that it grows so well certainly indicates adaptation. Orchard grass is not, however, to be recommended for western Nebraska except in canyons and on the flood plains of streams. In eastern Nebraska it should come into general favor.

Porcupine-grass (*Stipa spartea* Trin.) is as common on the dry, sterile hills of central Iowa as it is in western Iowa. It has the habit of growing in large bunches, from 1½ to 3½ feet high, with leaves often more than a foot long. It is useful as a pasture plant only early in the season or when kept closely cropped. It is often troublesome after the 10th of June, since the barbed "seed" is then either forming or ripe, and is liable to inflict injury to sheep. The danger from this has become less in recent years, as the grass rarely regains its hold upon cultivated soil. After the

"spears" have fallen the grass may be cut for hay. In Nebraska it is common only in the eastern part, occurring on high prairies and the slopes of hills. Although regarded as a pest in pastures, it is valued as a hay grass.

Prairie June-grass (*Koeleria cristata* Pers.) (fig. 9) grows abundantly on the prairies and dry hills of Nebraska and Iowa. It comes on early and retains its nutritious qualities even after the leaves become dry. It is common about Omaha, Crete, and McCook. In Colorado

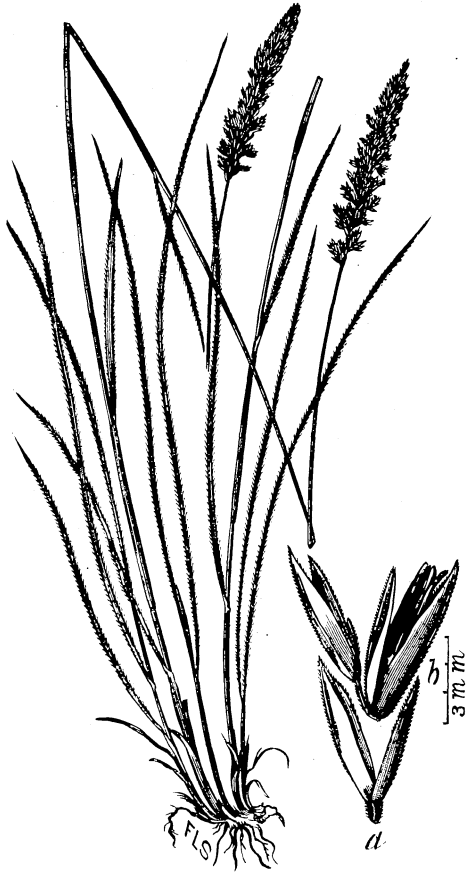


FIG. 9.—Prairie June-grass (*Koeleria cristata*): a, empty glumes; b, the two florets raised above the empty glumes.

it is one of the most abundant of the grasses in dry places in the foothills. Great quantities of it were observed near Fort Collins and Golden and at Colorado Springs, at an altitude of 7,000 to 8,000 feet. It was closely cropped, showing evidences of being relished by stock. Though an insignificant grass, so far as bulk is concerned it is one of the more valuable species of the foothills.

Red Clover (*Trifolium pratense*) is the chief leguminous forage plant of central and western Iowa. It is not quite as successful in the northwestern part of the State as further east, yet fine fields were observed near Sioux City the past season. Farmers sow the seed in early spring, either with or without a nurse crop. Nearly every farmer has his clover patch. It is used as a fertilizer as well as a hay crop. The first crop is cut for hay, while the second is often used for seed. It is a common practice to pasture after hay has been removed.

Red-Top (*Agrostis alba*) grows wild in low grounds, although it is seldom sown. It makes excellent hay, but as yet is not much of a factor in the forage of the State. It is a valuable grass in eastern Nebraska, especially in low ground, where it has been tried by many of the farmers, and is more common, as a naturalized plant, than Orchard-grass. It was observed in western Nebraska about McCook, in the Republican Valley, where it seems to be a most valuable addition.

Reed Canary-grass (*Phalaris arundinacea*) is more common and of greater value as a native forage plant under present conditions than Wild-Rice or Reed-grass. It matures early, produces a large number of bright green leaves that may be used with considerable advantage for hay in June. The soil in which it grows is often so wet, however, that the stock obtain it with considerable difficulty. The leaves remain green for some time after the seed has formed. It is common near Jefferson, Council Bluffs, Missouri Valley, and Sioux City, Iowa.

Reed-grass (*Phragmites vulgaris*) was once abundant and is still common in western and central Iowa, about old lake beds and marshes. It is of little value as a forage plant. In Nebraska it is common in very wet marshes along streams. Specimens from 12 to 14 feet high were observed near McCook.

Rye (*Secale cereale*). Farmers do not fully appreciate the great value of rye as a forage plant. It is used to a large extent and fully meets the requirements for fall, winter, and early spring pasturage. It is usually sown in the fall, and as soon as it is 4 or 5 inches high it will stand a moderate amount of grazing, which can be kept up through the winter and early spring. In the spring it affords a greater abundance of pasture than Blue-grass. Farmers who have used it commend it most highly for this purpose. One farmer complained that butter acquired a peculiar taste when the cows were fed on rye, but that was probably due to some other cause.

Sheep's Fescue (*Festuca ovina* L.). Several forms occur in the foothills of Colorado. On the steep sides of rough and rocky mountains it grows in small bunches with numerous firm leaves. Here it is a most valuable grass.

Short-awned Brome (*Bromus breviaristatus* Thurb.) (fig. 10) has been introduced and grown for a number of years in central and western Iowa. The results have been very satisfactory. Two crops may, under favorable conditions, be cut in a single season. It is nearly as valuable as Hungarian Brome, and is worthy of a more extended trial. In Colorado it is common in some gulches in the vicinity of Fort Collins at an altitude of 6,000 feet, and is equal in point of vigor to Hungarian Brome-grass. It produces an abundance of large, soft leaves, and the forage is well liked by stock.

Side Oats Grama or Tall Grama (*Bouteloua curtipendula*) (fig. 11) is common on hills in central and western Iowa. It is a valuable grass of the loess, occurring abundantly on rather dry soils. The hay made from it is of the very best quality. It cures readily, and even when cut late in the season the leaves retain their

freshness longer than many other wild grasses. It occurs throughout Nebraska, but was apparently most abundant in the eastern half of the State. It makes a fine growth of leaves, and is highly prized by farmers for hay and grazing.

Sleepy-grass (*Stipa robusta* Scribn.) is common at altitudes of from 5,000 to 5,500 feet, growing in large patches. Although cattle are numerous everywhere in this region, they apparently do not touch this grass. It flowers much later than Feather Bunch-grass (*Stipa viridula*).



FIG. 10.—Short-awned Brome-grass (*Bromus breviaristatus*): a, the floret seen from the side; b, palea; c, joint of the rachilla; d, grain; f, young seed or grain; e, lower portion of pistil, showing lodicules.

Slender-Fescue (*Festuca octoflora* Walt.) was observed not only in the foothills about Fort Collins, but also at Golden and Colorado Springs, Colo., from 5,000 to 9,000 feet. It is an annual, and in dry soil rarely attains a height of more than 4 inches, but in more sheltered and moister places it reaches a foot in height. This grass is at best of little value as a forage plant.

Slender Wheat-grass (*Agropyron tenerum* Vasey), mentioned as occurring along irrigation ditches throughout northern and central Colorado, is a valuable mountain grass. It grows in marshy meadows, attaining a height of 4 feet, with a large number of soft leaves and a long slender spike. It adds much to the forage of these mountain meadows, and would be far preferable to barley as a productive crop.



FIG. 11.—Side Oats Grama (*Bouteloua curtipendula*): a, one of the short spikes; b, a spikelet; c, a spikelet with the outer empty glumes removed.

Squirrel-tail grass (*Hordeum jubatum* L.) is common in Iowa and Nebraska, but it may be questioned whether it should be included among the forage grasses. It grows everywhere in meadows and pastures throughout the State. Squirrel-tail grass affords some pasturage early in the spring and in the fall, when the young plants come up abundantly after the rains. If allowed to head out, it soon becomes a troublesome pest.

Swamp-Chess (*Bromus ciliatus*) is of frequent occurrence in Iowa. The variety *purgans* matures its seed in June or early July, and occurs chiefly in woodland pastures where it is of considerable value. It is not as vigorous or as large a grass as the species, which matures in August. The latter has large culms and panicles with an abundance of leaves. This chess is certainly valuable for Iowa. It also occurs in eastern Nebraska, chiefly in woods and low

meadows, where it affords considerable forage, and seems worthy of a trial under cultivation. In Colorado the variety *purgans* is one of the most common of this genus at an altitude 6,000 to 7,000 feet about Golden. It is especially common in pine and spruce woods. It grows as vigorously at this altitude as in Iowa.

Switch-grass (*Panicum virgatum* L.) is common and productive everywhere in central and western Iowa. It grows abundantly in native prairie sod and along railroads. It is by no means confined to the bottom land or the richer prairie soil, being frequently found on sandy or gravelly drift, but it affords more and better forage on the richer soil. It is used for both hay and pasturage, but is of much less value as a pasture grass than for hay. It has been tried in a small way under cultivation in central Iowa, with promising results. The trials have not been extended enough, however, to recommend it for general culture. In eastern Nebraska it is abundant on the prairies, river bottoms, and open wooded slopes, and it was observed as far west as McCook, where the common form had a bluish color.

Tall Oat-grass (*Arrhenatherum elatius* Beauv.) has been tried in Iowa, and although it stands drought and cold well and makes a good growth, it has not come into general cultivation.

Texas Crab-grass (*Schedonnardus paniculatus* Trelease) is a common species in western Nebraska, and also occurs near Lincoln and Crete. About Hastings, Oxford, and McCook it is abundant on the high prairies. It is also abundant in the sandy flood plains of the Republican Valley. Cattle apparently seldom eat it, except when the grass is young and tender.

Timothy (*Phleum pratense* L.) is the best known of our hay grasses. It is used but little as a pasture grass. The bulbous thickening of the rootstock is apt to be pulled out by cattle or injured by tramping. Farmers generally use it as a meadow grass, sowing it in early spring either with or without a nurse crop or with Red Clover. In the latter case the clover predominates the first season, but in the second and third seasons the timothy is more abundant and less rank than when grown by itself. Hay consisting of this mixture is excellent and is generally preferred to any other. Timothy is well adapted to eastern Nebraska, where it succeeds better on low grounds than on the higher prairies. I saw very fine fields in 1896. Timothy is one of the best known of the cultivated grasses of eastern Nebraska, and is fully as much at home here as in western Iowa. In Colorado it is frequent as an introduced grass in moist gulches and canyons at an elevation of from 5,000 to 7,000 feet. It also grows at a higher altitude, though not so common there. Mountain timothy (*Phleum alpinum*) grows in moist woods and marshes at higher elevations in northern Colorado, from 8,000 to 10,000 feet. Where cattle grazed this grass was closely cropped, and was of considerable value as a forage plant.

Triple-awned Beard-grass (*Aristida fasciculata* Torrey) grows in dry places between Omaha and Lincoln, Nebr., but west of Lincoln it becomes very common. This grass is of value only when young, as the stems and leaves soon become wiry and harsh. Though not considered of much value on the plains, it is not without merit in the foothills. It grows in small bunches, having numerous fine leaves.

Turkey-foot-grass (*Andropogon hallii* Hack.) (fig. 12) was observed



FIG. 12.—Turkey-foot-grass (*Andropogon hallii*): a, a pair of spikelets; b, the first empty glume of the sessile spikelet; c, second empty glume; d, the third glume; e, fourth or flowering glume; f, palea showing a pistil and lodicules.

only in the sandhill region of western Nebraska. Here it produces an exuberant growth, 4 to 6 feet high, with a large number of leaves. It should be cut early if used for hay. Cattle are fond of the grass when young and fatten on it. Many farmers believe that for range purposes the sandhills are much superior to the country east, and Turkey-foot is one of the most important grasses of the region.

Western Brome grass

(*Bromus pumpehianus*) occurs in large patches, at an altitude of 9,500 to 10,000 feet. It is a striking green grass from 2 to 3 feet high, and forms a splendid turf. For cooler regions and in moist places this would no doubt prove valuable under cultivation.

White Clover (*Trifolium repens*) is a fickle plant

in Iowa. An abundance

of moisture is essential for its full development. When this condition is fulfilled it affords fine pasturage. Very few farmers ever sow white clover. In 1894 and 1895 it was not abundant, but in 1896 the Blue-grass meadows were white with it in June. It has been suggested that the winters are too severe and the plants are killed. Periodical scarcity of white clover is more than likely

to be associated with diminished seed production, caused by dry weather. The plant blossoms freely during moist weather, attracting the honey-bees, its chief pollinators. Moist weather accelerates seed production, as well as vegetative growth.

Wild Rye (*Elymus canadensis*) is very abundant on the prairies, low flats, and along the smaller streams in both Iowa and Nebraska. On valley lands it sometimes makes up more than half the wild hay. The forage is excellent when cut in time, but it is of little value as cut here in ordinary practice. It is usually cut in August, when the dead spikes stand out conspicuously among Blue-stem. There is often great danger in using such hay, as it frequently contains ergot—as many as eight or nine ergotized grains having been observed in a single head. The only safe course to pursue is to cut the grass in July, before the ergot has formed. In favorable seasons the meadow will produce a good second crop, which can be used as autumn pasture.

Wild Vetch (*Hosackia purshiana* Benth.), a native legume on low prairies in Nebraska, is a most valuable plant and worthy of cultivation. It has established itself in central Iowa, and is not uncommon on the loess region along the Missouri.

Wire grass (*Poa compressa* L.) is frequent in dry woods and in sterile soils in Iowa, and under such conditions is a valuable plant, forming a dense and close turf. It was observed in eastern Nebraska in the vicinity of Omaha and also as far west as McCook, in Red Willow County, where it grows without irrigation. It thrives in drier places and poorer soils than Blue-grass. This grass is worthy of encouragement, for though less productive than Blue grass, it furnishes good forage where better grasses will not grow.

LIST OF GRASSES COLLECTED IN IOWA, NEBRASKA, AND COLORADO.

The accompanying list is based on specimens collected at the following points:

In Iowa: Jefferson, Carroll, Carnarvon, Sioux City, Logan, Missouri Valley, and Council Bluffs.

In Nebraska: Lincoln, Crete, Oxford, and McCook.

In Colorado: Fort Morgan, Greeley, Fort Collins, La Porte, and other points in Larimer County. Along the tributaries of the Cache la Poudre River, Denver, near the mouth of Clear Creek Canyon, Golden, Colorado Springs, and North Cheyenne Canyon.

The higher altitudes as here given are based on field observations. The altitudes of lower points are based on Henry Gannett's Dictionary of Altitudes, and are approximate only for these places.

ANDROPOGONEÆ.***Andropogon nutans avenaceus* Hack.**

Iowa: Carroll, altitude 1,240 feet; Carnarvon, altitude 1,200 feet; Missouri Valley, altitude 1,022 feet.

***A. provincialis furcatus* (Muhl.) Hack.**

Iowa: Carroll, altitude 1,240 feet; Sioux City, altitude 1,200 feet; Carnarvon, altitude 1,200 feet.

Nebraska: McCook, altitude 2,517 feet.

***A. scoparius* Michx.**

Iowa: Sioux City, altitude 1,230 feet; Carroll, altitude 1,240 feet; Missouri Valley, altitude 1,030 feet.

PANICEÆ.***Panicum capillare* L.**

Iowa: Missouri Valley, altitude 1,022 feet; Jefferson, altitude 1,118 feet; Carroll, altitude 1,240 feet; Sioux City, altitude 1,122 feet.

Nebraska: Crete, altitude 1,364 feet.

Colorado: Colorado Springs, altitude 5,978 feet; Fort Collins, altitude 4,984 feet; fields and roadsides.

***P. crus-galli* L.**

Iowa: Jefferson, altitude 1,118 feet, abundant in fields, gardens, and along roads.

Colorado: Fort Collins, altitude 4,984 feet, along irrigation ditches or in moist places.

***P. crus-galli muticum* Vasey.**

Colorado: Fort Morgan, altitude 4,500 feet, moist places and sandy bottoms of Platte River.

***P. glabrum* Gaudin.**

Iowa: Missouri Valley, altitude 1,015 to 1,025 feet; Sioux City, altitude 1,110 to 1,125 feet, not common.

***P. proliferum* Lam.**

Iowa: Missouri Valley, altitude 1,022 feet; Council Bluffs, altitude 990 to 1,025 feet; Carroll, altitude 1,240 feet.

Nebraska: Lincoln, altitude 1,159 feet, fields and roadsides.

***P. sanguinale* Linn.**

Iowa: Jefferson, altitude 1,118 feet; Council Bluffs, altitude 990 to 1,025 feet; Sioux City, altitude 1,122 feet; Carroll, altitude 1,240 feet.

Nebraska: Lincoln, altitude 1,159 feet.

***P. scribnerianum* Nash.**

Iowa: Council Bluffs, altitude 990 to 1,025 feet, common.

Nebraska: Crete, altitude 1,364 to 1,400 feet, prairies.

***P. virgatum* L.**

Iowa: Carroll, altitude 1,240 feet; Sioux City, altitude 1,122 feet, abundant.

Nebraska: McCook, altitude 2,517 feet, flood plains of Republican River and prairies.

***Chaetochloa glauca* (L.) Scribn.**

Iowa: Jefferson, altitude 1,118 feet; Council Bluffs, altitude 990 feet; Sioux City, altitude 1,122 feet; Carroll, altitude 1,240 feet.

***C. italica* (L.) Scribn.**

Iowa: Carroll, altitude 1,240 feet; Sioux City, altitude 1,122 feet; Jefferson, altitude 1,118 feet.

Nebraska: Crete, altitude 1,364 feet, an escape from cultivation and spontaneous along railroads.

***C. verticillata* (L.) Scribn.**

Iowa: Council Bluffs, altitude 1,025 feet, introduced.

C. viridis (L.) Scribn.

Iowa: Jefferson, altitude 1,118 feet; Council Bluffs, altitude 990 feet; Carroll, altitude 1,240 feet; Sioux City, altitude 1,122 feet.

Nebraska: Crete, altitude 1,364 feet, a common weed.

Cenchrus tribuloides L.

Iowa: Carroll, altitude 1,240 feet; Sioux City, altitude 1,115 feet; Missouri Valley, altitude 1,015 to 1,028 feet; Council Bluffs, altitude 985 to 995 feet; abundant in Iowa along railroads where sand and gravel ballast are used, also in flood plains of streams.

Nebraska: McCook, altitude 2,517 feet, abundant; sandy flood plain of Republican River.

ORYZÆ.**Homalocenchrus oryzoides** (L.) Poll.

Iowa: Carroll, altitude 1,230 feet; Sioux City, altitude 1,115 feet; Jefferson, altitude 1,118 feet, abundant in low grounds.

H. virginicus (Willd.) Britt.

Iowa: Carroll, altitude 1,240 feet; Jefferson, altitude 1,118 feet; Sioux City, altitude 1,122 feet, frequent.

Nebraska: Crete, altitude 1,364 feet, in woods near streams.

PHALARIDÆ.**Phalaris arundinacea** L.

Iowa: Jefferson, altitude 1,118 feet; Sioux City, altitude 1,115 feet.

Colorado: Greeley, altitude 4,770 feet, low grounds along irrigation ditches.

Savastana odorata (L.) Scribn.

Colorado: Beaver Creek, Larimer County, altitude 8,500 feet.

AGROSTIDÆ.**Aristida fasciculata** Torr.

Nebraska: Lincoln, altitude 1,159 feet; McCook, altitude 2,517 feet; very common not only in flood plains of Republican River, near McCook, but on the adjacent hills.

Colorado: Denver, altitude 5,182 to 6,000 feet; Golden, altitude 5,691 to 6,000 feet; Mount Zion near Golden, altitude 7,500 feet; La Porte, altitude 5,000 feet; Fort Morgan. Abundant on the plains, as well as the sandy foothills near La Porte. At higher altitudes usually a short grass.

Stipa comata Trin. and Rupr.

Nebraska: McCook, altitude 2,507 feet.

Colorado: North Cheyenne Canyon near Colorado Springs, altitude 6,000 feet; Fort Collins, altitude 4,984 feet; Fort Morgan; La Porte, altitude 5,095 feet, dry soil, red sandstone.

Stipa pinnata neo-mexicana Thurb.

Colorado: La Porte, altitude 5,095 feet; rare in dry, red soil.

S. robusta Scribn.

Colorado: Long Gulch, Larimer County, altitude 7,800 feet; Bosworth Ranch, Larimer County, altitude 7,500 feet, abundant on flats in meadows; Beaver Creek, Larimer County, altitude 9,500 feet.

S. spartea Trin.

Iowa: Sioux City, altitude 1,122 feet; Jefferson, altitude 1,118 feet; Council Bluffs, altitude 990 to 1,000 feet; a common grass in Iowa; high, dry prairies and loess along the Missouri.

S. viridula Trin.

Nebraska: McCook, altitude 2,517 feet, flood plains of Republican River.

Colorado: Fort Collins, altitude 4,978 to 5,000 feet, high banks of irrigation ditches; Colorado Springs, altitude 5,978 feet.

Eriocoma cuspidata Nutt.

Colorado: Fort Morgan, Platte River, altitude 4,990 feet, sandy soil, second bottoms; east of Denver, sand hills, altitude 5,100 to 5,300 feet; La Porte, sand hills, red sandstone, altitude 5,095 feet.

Muhlenbergia gracilis Trin.

Colorado: Fort Collins, altitude 4,984 feet, dry prairies; Beaver Creek, Larimer County, altitude 9,500 to 10,000 feet, dry soil.

M. gracillima Torr.

Colorado: Colorado Springs, altitude 5,978 to 6,000 feet, grows in bunches, very dry soil.

M. mexicana Trin.

Iowa: Carroll, altitude 1,240 feet; Sioux City, altitude 1,122 feet; Missouri Valley, altitude 1,022 feet, along roadsides.

M. racemosa (Michx.) B. S. P.

Iowa: Missouri Valley, altitude 1,022 feet; Council Bluffs, altitude 1,000 feet; Jefferson, altitude 1,118 feet; Carroll, altitude 1,240 feet; Sioux City, altitude 1,122 feet.

Nebraska: Crete, altitude 1,364 feet, moist prairies, abundant.

Phleum alpinum L.

Colorado: Happy Hollow, Larimer County, altitude 8,300 feet, low marshy grounds; Beaver Creek, Larimer County, altitude 9,000 to 10,000 feet, subalpine, in canyons and swamps, common.

P. pratense L.

Iowa: Carroll, altitude 1,240 feet; Sioux City, altitude 1,122 feet; Jefferson, altitude 1,118 feet; Missouri Valley; Logan.

Nebraska: McCook, altitude 2,517 feet, in moist grounds.

Colorado: Beaver Creek, Larimer County, altitude 9,100 feet, along trail, high grounds; trail above Beaver Creek, Larimer County, altitude 10,500 feet, with a strongly developed corm-like bulb. Timothy is common throughout the irrigated districts of northern Colorado.

Alopecurus geniculatus L.

Colorado: Long Gulch, Larimer County, bank of Little Beaver, altitude 8,500 feet, rooting in mud.

A. geniculatus fulvus (J. E. Smith) Scribn.

Colorado: South Branch Cache la Poudre River, Larimer County, altitude 7,975 feet, rooting in mud; Greeley, altitude 4,770 feet.

Sporobolus airoides Torr.

Colorado: Fort Collins, altitude 4,950 feet, near Cache la Poudre River; La Porte, Larimer County, altitude 5,095 feet, sandstone soil; Fort Morgan, altitude 4,500 feet.

S. asperifolius Thurb.

Colorado: La Porte, Larimer County, altitude 5,095 feet, red sandstone; Fort Morgan, altitude 4,500 feet, sandy second bottom of Platte River.

S. brevifolius (Nutt.) Scribn.

Iowa: Missouri Valley, altitude 1,022 feet; Carroll, altitude 1,250 feet; Sioux City, altitude 1,122 to 1,130 feet; Missouri Valley, altitude 1,025 to 1,030 feet; Council Bluffs, altitude 1,020 to 1,040 feet.

Colorado: North Cheyenne Canyon, near Colorado Springs, near mouth of canyon, dry soil, altitude 6,000 feet.

S. cryptandrus (Torr.) A. Gray.

Iowa: Missouri Valley, altitude 1,022 feet.

Nebraska: Crete, altitude 1,364 to 1,500 feet, dry hills; McCook, altitude 2,517 to 2,700 feet.

Colorado: Denver, plains, altitude 5,294 feet; Fort Morgan, altitude 4,500 feet.

***S. depauperatus* (Torr.) Scribn.**

Colorado: La Porte, Larimer County, altitude 5,050 feet, sandy soil.

***S. heterolepis* A. Gray.**

Iowa: Carroll, altitude 1,240 feet.

***S. longifolius* (Torr.) Wood.**

Iowa: Carroll, altitude 1,240 feet; Sioux City, altitude 1,122 feet, prairies and loess.

Nebraska: Hastings, prairies.

***S. vaginæflorus* Vasey.**

Iowa: Carroll, altitude 1,240 feet, roadsides, common; Sioux City, altitude 1,122 to 1,130 feet, common.

***Agrostis alba* L.**

Iowa: Carroll, altitude 1,240 feet; Jefferson, altitude 1,118 feet; Logan, Council Bluffs, altitude 990 to 1,025 feet.

Nebraska: Crete, altitude 1,364 feet; McCook, altitude 2,517 feet, common in low grounds, along small streams, in pastures and meadows.

***A. exarata* Trin.**

Colorado: La Porte, Larimer County; marsh near Cache la Poudre River, altitude 4,990 feet; Greeley, altitude 4,770 feet, irrigated flats; Beaver Creek, Larimer County, altitude 500 feet, in swamps.

***A. scabra* Willd.**

Iowa: Sioux City, altitude 1,122 feet.

Colorado: Beaver Creek, Larimer County, altitude 9,100 feet, in woods of *Pinus murrayanus*, along trail.

***Polypogon monspeliensis* (L.) Desf.**

Colorado: Fort Collins, altitude 4,954 feet, along irrigation ditches.

***Calamagrostis canadensis* (Michx.) Beauv.**

Iowa: Jefferson, altitude 1,118 feet, low moist prairies and bottoms of small streams, common throughout western Iowa.

***C. purpurascens* R. Br.**

Colorado: Beaver Creek, Larimer County, altitude 10,000 to 11,000 feet, in dry woods and open places; grows in large bunches.

***Calamovilfa longifolia* (Hook.) Scribn.**

Iowa: Carroll, altitude 1,240 feet; Sioux City, altitude 1,122 feet.

Nebraska: McCook, altitude 2,517 feet, common loess bluffs along Missouri River.

AVENÆ.***Deschampsia flexuosa* (L.) Trin.**

Colorado: North Cheyenne Canyon, near Colorado Springs, altitude 6,500 feet.

***D. cæspitosa* (L.) Beauv.**

Colorado: Beaver Creek, Larimer County, altitude 9,800 to 11,000 feet, in low grounds and swamps; Long Gulch, altitude 7,775 feet.

***Trisetum subspicatum* Beauv.**

Colorado: Mountain trail, Pikes Peak, altitude 11,720 feet; Beaver Creek, Larimer County, altitude 10,500 to 11,200 feet, abundant in woods and open places.

***Avena fatua* L.**

Colorado: Fort Collins, altitude 4,978 to 5,000 feet; Denver, altitude 5,000 feet, weed in grain fields.

***Danthonia intermedia* Vasey.**

Colorado: Beaver Creek, Larimer County, altitude 9,100 feet; Bosworth Ranch, altitude 7,500 feet, in open pine woods, abundant.

CHLORIDEÆ.

***Spartina cynosuroides* (L.) Willd.**

Iowa: Carroll, altitude 1,230 feet; Sioux City, altitude 1,115 feet; Missouri Valley, altitude 1,015 feet, abundant, alluvial bottoms and sloughs.

Nebraska: McCook, marshes along Republican River, altitude 2,512 feet

***S. gracilis* Trin.**

Nebraska: McCook, alkaline marshes of Republican River, altitude 2,512 feet.

Colorado: La Porte, Larimer County, marsh, altitude 5,100 feet.

***Schedonnardus paniculatus* (Nutt.) Trelease.**

Nebraska: Lincoln, altitude 1,159 feet; Crete, altitude 1,364 feet, dry hills; Hastings, dry prairies; McCook, altitude 2,517 feet, second bench lands, flood plain Republican River and low hills.

Colorado: Greeley, altitude 4,779 feet, dry soil, plains.

***Bouteloua curtipendula* (Michx.) A. Gray.**

Iowa: Carroll, altitude 1,240 feet; Sioux City, altitude 1,122 feet; Missouri Valley, altitude 1,022 feet; Logan, altitude 928 feet, high prairies and loess bluffs along the Missouri.

Nebraska: Crete, altitude 1,364 feet; McCook, altitude 2,517 feet.

***B. oligostachya* (Nutt.) Torr.**

Nebraska: Lincoln, altitude 1,159 feet; Crete, altitude 1,364 feet; Hastings; Oxford, altitude 2,085 feet; McCook, altitude 2,517 feet, common, prairies, flood plain of the Republican River.

Colorado: Near Colorado Springs, altitude 5,978 feet; Denver, altitude 5,200 feet; Fort Collins, altitude 4,984 feet; Greeley, altitude 4,779 feet; Fort Morgan, altitude 4,500 feet; Stove Prairie, Larimer County, altitude 7,800 feet, not common.

***Beckmannia erucaeformis* (L.) Host.**

Colorado: Fort Collins, altitude 4,980 feet; Greeley, altitude 4,770 feet.

***Bulbilis dactyloides* (Nutt.) Raf.**

Nebraska: Lincoln, altitude 1,159 feet, local; Crete, altitude 1,364 feet, local; Hastings, abundant; McCook, altitude 2,517 feet, high hills and flood plains of Republican River.

Colorado: Fort Collins, altitude 4,984 feet, plains; Fort Morgan, altitude 4,500 feet, plains, and flood plain of Platte River.

FESTUCEÆ.

***Munroa squarrosa* (Nutt.) Torr.**

Nebraska: McCook, altitude 2,517 feet, abundant, flood plain of Republican River.

Colorado: Denver, altitude 5,200 feet, high plains; Fort Morgan, altitude 4,500 feet, high plains; Golden, altitude 5,691 feet.

***Phragmites vulgaris* (Lam.) B. S. P.**

Iowa: Sioux City, altitude 1,115 feet; Council Bluffs, altitude 990 feet, low grounds.

Nebraska: McCook, altitude 2,512 feet.

Colorado: Fort Collins, altitude 5,100 feet, marshes.

***Redfieldia flexuosa* (Thurb.) Vasey.**

Colorado: Fort Morgan, altitude 4,500 feet, sandy bottoms of Platte River, common.

***Eragrostis major* Host.**

Iowa: Jefferson, altitude 1,118 feet; Carroll, altitude 1,240 feet; Sioux City, altitude 1,122 feet; Council Bluffs, altitude 990 to 1,000 feet, roadsides.

Nebraska: McCook, altitude 2,517 to 2,550 feet, roadsides.

***E. pectinacea* (Michx.) Steud.**

Nebraska: Crete, altitude 1,364 feet; Lincoln, altitude 1,159 feet; McCook, altitude 2,517 feet.

E. purshii Schrad.

Iowa: Carroll, altitude 1,240 feet; Sioux City, altitude 1,122 feet; Council Bluffs, altitude 990 to 1,000 feet, common along roadsides.

E. hypnoides (Lam.) B. S. P.

Iowa: Carroll, altitude 1,240 feet; Sioux City, altitude 1,110 feet.

Eatonia obtusata (Michx.) A. Gray.

Iowa: Sioux City, altitude 1,122 feet.

Nebraska: McCook, altitude 2,517 to 2,550 feet, common, high prairies and in flood plain of Republican River.

Colorado: Fort Collins, altitude 4,984 feet.

E. pennsylvanica (D. C.) A. Gray.

Iowa: Jefferson, altitude 1,110 feet; Sioux City, altitude 1,122 feet; Council Bluffs, altitude 995 feet, low flood plain of rivers.

Koeleria cristata (L.) Pers.

Iowa: Jefferson, altitude 1,118 feet; Sioux City, altitude 1,122 feet; Logan, high prairies and loess bluffs along the Missouri.

Nebraska: McCook, altitude 2,517 feet.

Colorado: Foothills near Golden, altitude 7,500 feet; La Porte, altitude 5,095 feet, red sandstone hills; Long Gulch, Larimer County, altitude 7,775 feet, dry places, common.

Catabrosa aquatica (L.) Beauv.

Colorado: Fort Collins, altitude 4,984 feet, in seepage water from irrigation ditches; in gulch west of Fort Collins, altitude 5,500 feet, abundant in water.

Distichlis spicata (L.) Greene.

Nebraska: Lincoln, altitude 1,159 feet, salt marsh; McCook, altitude 2,517 feet, salt marsh, flood plain Republican River, base of hills.

Colorado: Denver, altitude 5,200 feet, in vacant lots.

Dactylis glomerata L.

Iowa: Carroll, altitude 1,240 feet; Sioux City, altitude 1,122 feet, common.

Nebraska: McCook, altitude 2,517 feet, not common.

Colorado: Golden, altitude 5,691 feet.

Poa arctica R. Br.

Colorado: Above Beaver Creek, Larimer County, at snow bank, altitude 10,000 feet; swamp, Beaver Creek Canyon, altitude 9,500 feet.

P. arida Vasey.

Nebraska: McCook, altitude 2,517 feet.

Colorado: Fort Collins, altitude 4,484 feet, in dry soil, plains; La Porte, altitude 5,500 feet; above Beaver Creek, Larimer County, altitude 10,000 feet, dry places.

P. buckleyana Nash.

Colorado: Beaver Creek, Larimer County, altitude, 9,100 feet; Golden; Mount Zion, altitude 7,500 to 8,000 feet; also in Clear Creek Canyon, altitude 7,500 feet, open grounds.

P. coloradoensis Vasey.

Colorado: Rists Canyon, altitude 6,500 feet.

P. compressa L.

Iowa: Carroll, altitude 1,240 feet; Sioux City, altitude 1,122 feet, dry banks along railroads.

Nebraska: Crete, altitude 1,364 feet, dry banks; McCook, altitude 2,517 feet.

Colorado: North Cheyenne Canyon, Colorado Springs, altitude 6,000 feet, in open grounds.

P. epilis Scribn.

Colorado: Above Beaver Creek, Larimer County, timber line, altitude 11,000 feet, also at snow bank, altitude 10,000 feet; and swamps, Beaver Creek Canyon, between 9,800 and 10,000 feet.

P. fendleriana Steud.

Colorado: Little Beaver, Larimer County, 9,100 feet; Beaver Creek Canyon, altitude 10,500 feet; south fork Cache la Poudre, Larimer County, altitude 8,500 feet.

P. flava L.

Colorado: Fort Collins, altitude 4,978 feet, low grounds near river; Greeley, altitude 4,779 feet, low grounds.

P. lucida Vasey.

Colorado: Golden, Clear Creek Canyon, altitude 7,500 feet.

P. lettermani Vasey.

Colorado: Pikes Peak, altitude 14,147 feet; timber line, altitude 11,700 to 13,600 feet, common and conspicuous among other grasses.

P. nemoralis L.

Colorado: Golden, Clear Creek Canyon; Mount Zion, altitude 6,500 to 7,500 feet; North Cheyenne Canyon, near Colorado Springs; mountain trail, Pikes Peak, altitude 11,000 feet; Fort Collins, altitude 4,950 feet, irrigated flats; in gulch west of Fort Collins, altitude 5,500 feet; above Beaver Creek, Larimer County, altitude 9,000 to 10,000 feet; Happy Hollow, Larimer County, altitude 7,900 feet; Rists Canyon, altitude 6,665 feet, common in the mountains in moist places.

P. pratensis L.

Iowa: Carroll, altitude 1,240 feet; Sioux City, altitude 1,122 feet.

Nebraska: Hastings; McCook, altitude 2,517 feet, in moist places.

Colorado: Colorado Springs, altitude 5,978 to 6,000 feet; Fort Collins, irrigated fields, altitude 4,978 feet; Bosworths Ranch, Larimer County, altitude 7,500 feet; Poverty Flats, Larimer County, altitude 7,800 feet, open, dry flats, grass much reduced in size; Happy Hollow, Larimer County, altitude 7,900 feet.

P. rupestris Vasey.

Colorado: Mountain trail, Pikes Peak, altitude 11,500 feet; above timber line, altitude 12,500 feet; above Beaver Creek, Larimer County, altitude 9,000 to 10,000 feet, in swamps.

P. tracyi Vasey.

Colorado: Fort Collins, gulch west of Pennock, altitude 5,500 feet, in lower places.

P. wheeleri Vasey.

Colorado: Beaver Creek, Larimer County, altitude 9,100 feet.

Puccinellia airoides (Nutt.) Wats. & Coult.

Colorado: Fort Collins, altitude 4,950 feet, near river; Greeley, altitude 4,770 feet, low grounds.

Panicularia nervata (Willd.) Kuntze.

Colorado: North Cheyenne Canyon, near Colorado Springs, altitude 8,000 feet, edges of brooks.

Festuca arizonica Vasey.

Colorado: Beaver Creek, Larimer County, altitude 9,100 to 9,500 feet, dry open places; Rists Canyon, altitude 6,500 feet, a stout harsh grass.

F. brevifolia R. Br.

Colorado: Beaver Creek, Larimer County, altitude 9,800 feet, dry sterile soil.

F. kingii (S. Wats.) Scribn.

Colorado: Little South Cache la Poudre, Larimer County, altitude 8,700 feet; Beaver Creek, Larimer County, altitude 9,500 feet.

F. ovina L.

Colorado: Mountain trail, Pikes Peak, altitude 11,000 feet (a form of); Beaver Creek, Larimer County, altitude 9,000 feet, dry soil; Happy Hollow, Larimer County, altitude 7,900 feet; Poverty Flats, Larimer County, altitude 8,020 feet.

F. octoflora Walt.

Iowa: Sioux City, altitude 1,122 feet.

Nebraska: Crete, altitude 1,364 feet; McCook, altitude 2,517 feet.

Colorado: Golden, altitude 5,691 feet; Mount Zion, near Golden, altitude 7,500 feet; Denver, altitude 5,294 feet, dry soil; common at all the above points.

Bromus breviaristatus Buckl.

Colorado: Fort Collins; gulch west of Pennock, Larimer County, altitude 5,500 feet, in moist soil.

B. ciliatus L.

Iowa: Sioux City, altitude 1,122 feet.

Colorado: Beaver Creek, Larimer County, altitude 9,100 to 9,800 feet, in rather dry woods.

B. ciliatus purgans A. Gray.

Colorado: Clear Creek Canyon, near Golden, altitude 7,000 feet, in spruce woods.

B. inermis Leyss.

Colorado: Fort Collins, altitude 4,974 feet, escaped from cultivation, College farm.

B. kalmii A. Gray.

Colorado: Stove Prairie, Larimer County, altitude 7,800 feet, dry open woods.

B. pumpellianus Scribn.

Colorado: Beaver Creek, Larimer County, altitude 9,500 feet.

B. tectorum L.

Colorado: Fort Collins, altitude 4,974 feet, escaped from cultivation, common station grounds, College farm.

B. unioides HBK.

Colorado: Fort Collins, altitude 4,974 feet, escaped from cultivation, College farm.

HORDEÆ.**Agropyron dasystachyum subvillosum** Scribn. and Smith.

Colorado: Bosworth ranch, Larimer County, altitude 7,500 feet, low meadows.

A. divergens Nees.

Colorado: Golden, altitude 5,691 feet, open low places; Clear Creek Canyon, altitude 6,500 to 7,000 feet; Beaver Creek, Larimer County, altitude 9,500 feet, swamp; Long Gulch, altitude 7,800 feet, low places.

A. divergens tenuispicum Scribn. and Smith.

Colorado: Happy Hollow, altitude 7,500 feet, low grounds.

A. pseudorepens Scribn. and Smith.

Colorado: Bosworth ranch, Larimer County, altitude 7,200 feet, in open woods.

A. repens (L.) Beauv.

Iowa: Carroll, altitude 1,240 feet; Sioux City, altitude 1,122 feet.

Nebraska: McCook, altitude 2,517 feet, introduced.

A. richardsoni Schrad.

Colorado: Stove Prairie, Larimer County, altitude 8,000 feet, in open, dry soil.

A. scribneri Vasey.

Colorado: Beaver Creek, Larimer County, at timber line, altitude 11,000 feet.

A. spicatum (Pursh) Scribn. and Smith.

Iowa: Sioux City, altitude 1,122 feet, loess soil, common.

Nebraska: Lincoln, altitude 1,159 feet; Crete, altitude 1,364 feet; Oxford, altitude 2,085 feet; McCook, altitude 2,517 feet; abundant, prairies.

Colorado: Fort Morgan, altitude 4,500 feet.

A. tenerum Vasey.

Colorado: Colorado Springs, altitude 5,978 feet; Fort Collins, altitude 4,970 feet, along irrigation ditches; Greeley, altitude 4,779 feet, along irrigation ditches.

***Hordeum jubatum* L.**

Iowa: Carroll, altitude 1,240 feet; Sioux City, altitude 1,123 feet; Council Bluffs, altitude 990 to 1,000 feet; Logan, altitude 928 feet; Jefferson, altitude 1,100 feet; abundant weed in meadows, pastures along roadsides, and along railroads.

Nebraska: Hastings, along railroads; McCook, altitude 2,517 feet, along railroads, sandy bottoms of Republican River.

Colorado: Fort Morgan, altitude 4,500 feet; Fort Collins, altitude 4,978 feet; along railroads, seepage swamps, and flats, abundant.

***H. pusillum* Nutt.**

Iowa: Council Bluffs, altitude 1,000 feet, introduced.

Nebraska: Crete, altitude 1,364 feet; Hastings, along railroads, dry prairie soil; McCook, altitude 2,517 feet, along railroads and prairies.

Colorado: Denver, altitude 5,294 feet, prairies; Fort Collins, altitude 4,978 feet.

***Elymus canadensis* L.**

Iowa: Carroll, altitude 1,240 feet; Sioux City, altitude 1,122 feet, loess bluffs; Jefferson, altitude 1,118 feet; Logan.

Nebraska: Lincoln, altitude 1,159 feet; Crete, altitude 1,364 feet, dry prairies, along railroads; McCook, altitude 2,517 feet, flood plains of Republican River.

Colorado: Fort Collins, altitude 4,984 feet, along railroads; Colorado Springs, altitude 5,978 feet; Rists Canyon, Larimer County, altitude 6,500 feet, dry open places.

***E. glaucus* Buckley.**

Nebraska: McCook, altitude 2,517 feet, dry places, flood plains Republican River.

***E. macounii* Vasey.**

Colorado: Greeley, altitude 4,770 feet, river bottoms; Fort Collins, altitude 4,900 feet, flats, Cache la Poudre River, common. The species has also been found near Jewell Junction, Iowa (Carver), in what was once an old lake bed.

***E. nitidus* Vasey.**

Colorado: Near Golden, Clear Creek Canyon, altitude 6,000 to 7,000 feet, in yellow pine woods.

***E. robustus* Scribn. and Smith.**

Iowa: Carroll, altitude 1,240 feet.

***E. striatus* Willd.**

Iowa: Carroll, altitude 1,240 feet; Sioux City, altitude 1,122 feet; Jefferson, altitude 1,118 feet; Council Bluffs, altitude 990 feet.

***E. triticoides* Buckl.**

Colorado: Near Golden, Clear Creek Canyon, altitude 7,500 feet, in woods.

***E. virginicus* L.**

Iowa: Jefferson, altitude 1,118 feet; Sioux City, altitude 1,122 feet; Council Bluffs, altitude 990 feet; Logan, altitude 928 feet; Missouri Valley, altitude 1,022 feet.

***Sitanion elymoides* Raf.**

Nebraska: McCook, altitude 2,517 feet, abundant, flood plains Republican River.

Colorado: Denver, altitude 5,294 feet, abundant, dry plains; Golden, altitude 7,000 feet; Mount Zion, near Golden, altitude 7,500 feet; Colorado Springs, altitude 5,978 feet; North Cheyenne Canyon, near Colorado Springs, altitude 6,500 feet; Fort Morgan, altitude 4,500 feet.

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